
Model-based Autonomous Systems

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Outline

- Introduction
- Overview
- Model-based configuration management
- Combinatorial optimization
- LTMS
- Incorporating dynamics
- Model-based execution and model-based reactive planning
- Conclusions
- ITMS

Emergence of Complex Autonomous Systems

- Availability of cheap networked control processors
- Emergence of realtime graphical programming environments
 - control shell, labview, simulink,
 - rule-based control G*
- more sophisticated realtime operating systems
 - VXWORKS
- Platform independent embedded language kernels
 - Java.

Mobile Robots

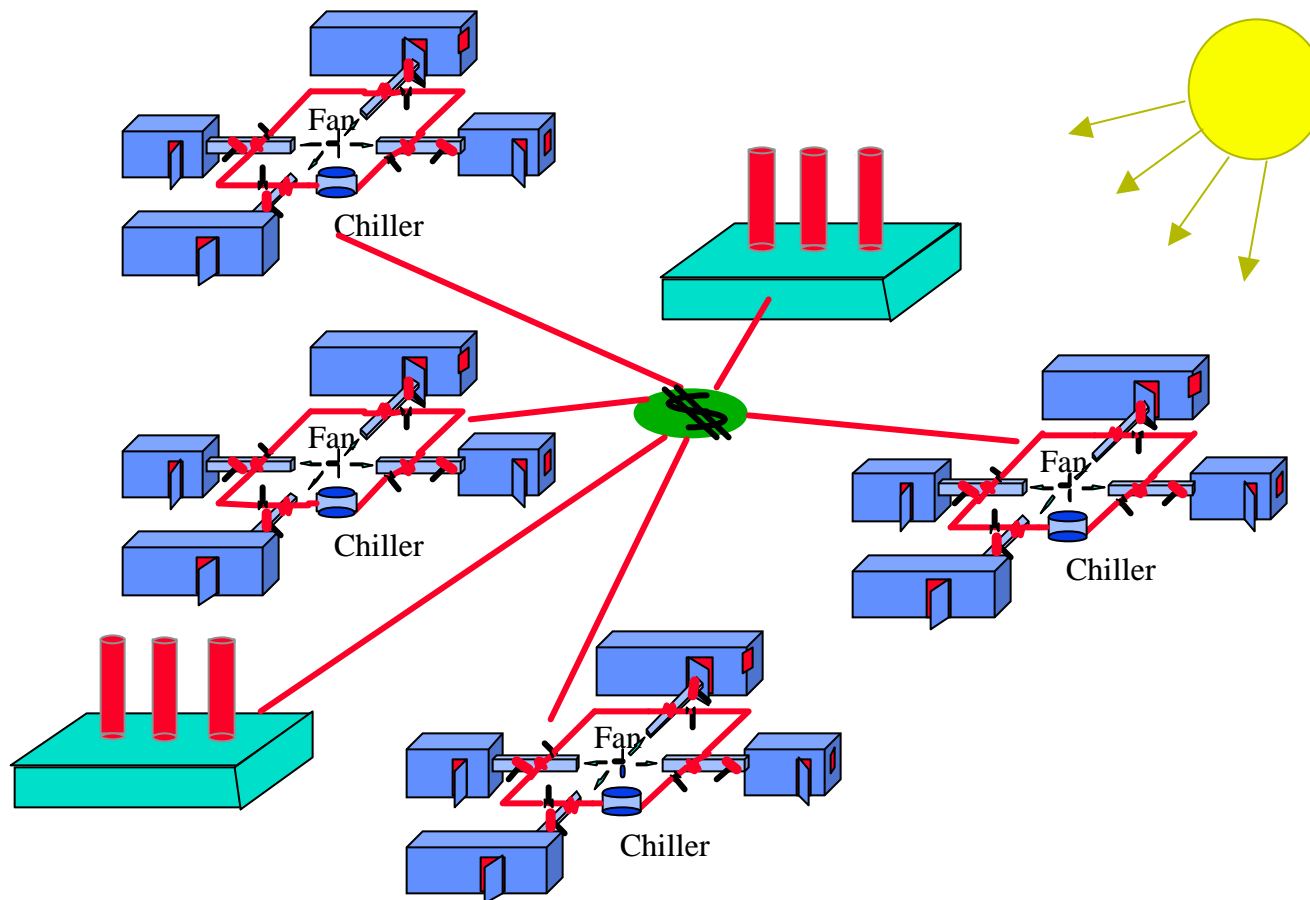
Field

Indoor



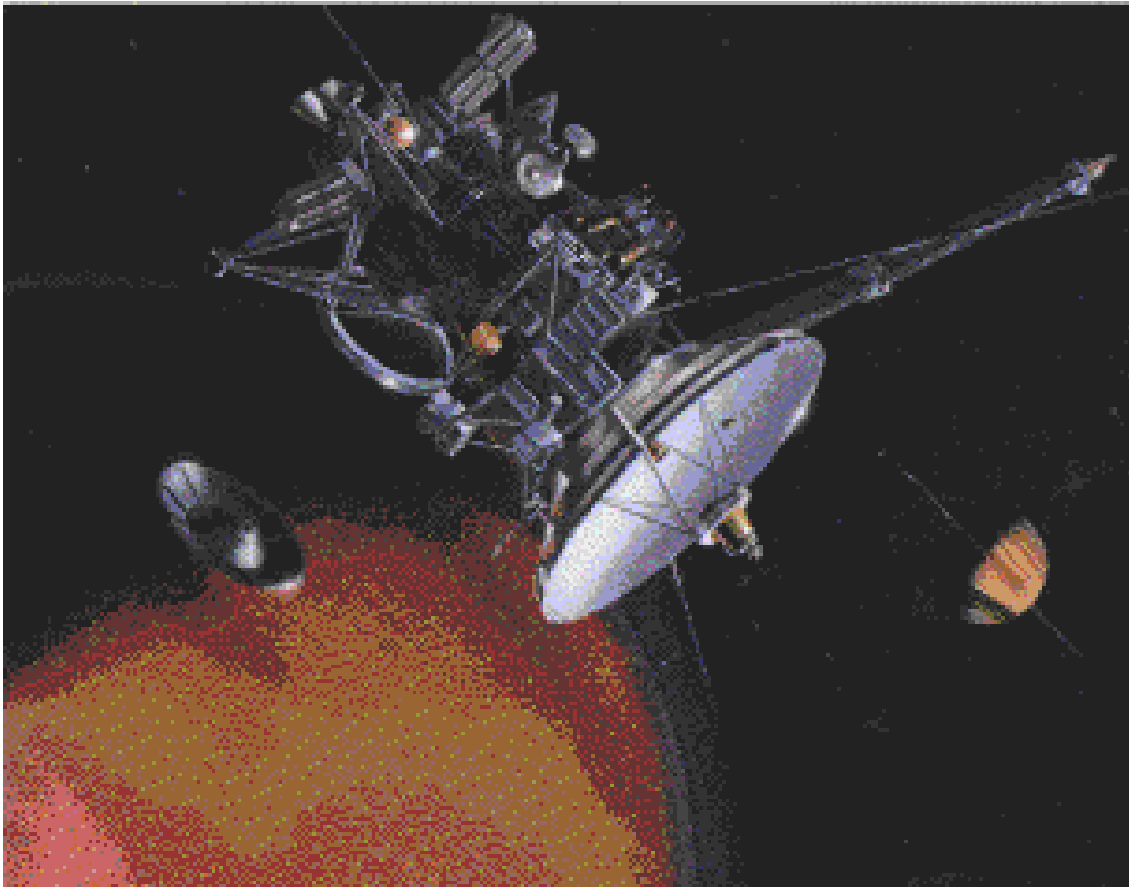
Immobile Robots

Example 1: Autonomy on a Global Scale

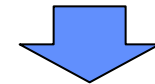


Intelligent buildings, power grids, factories and highways.

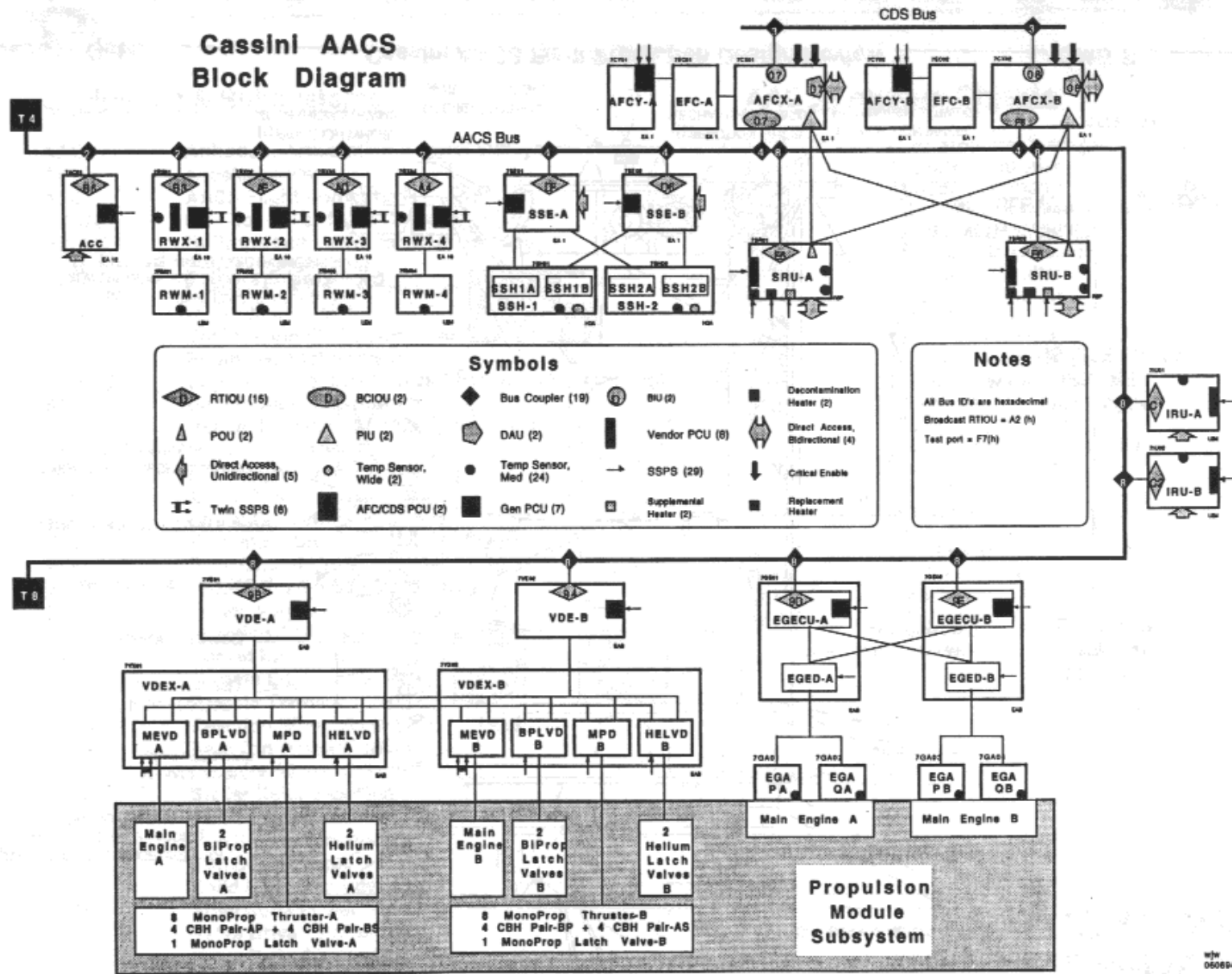
Immobile Robots Example 2: Cassini Saturn Mission



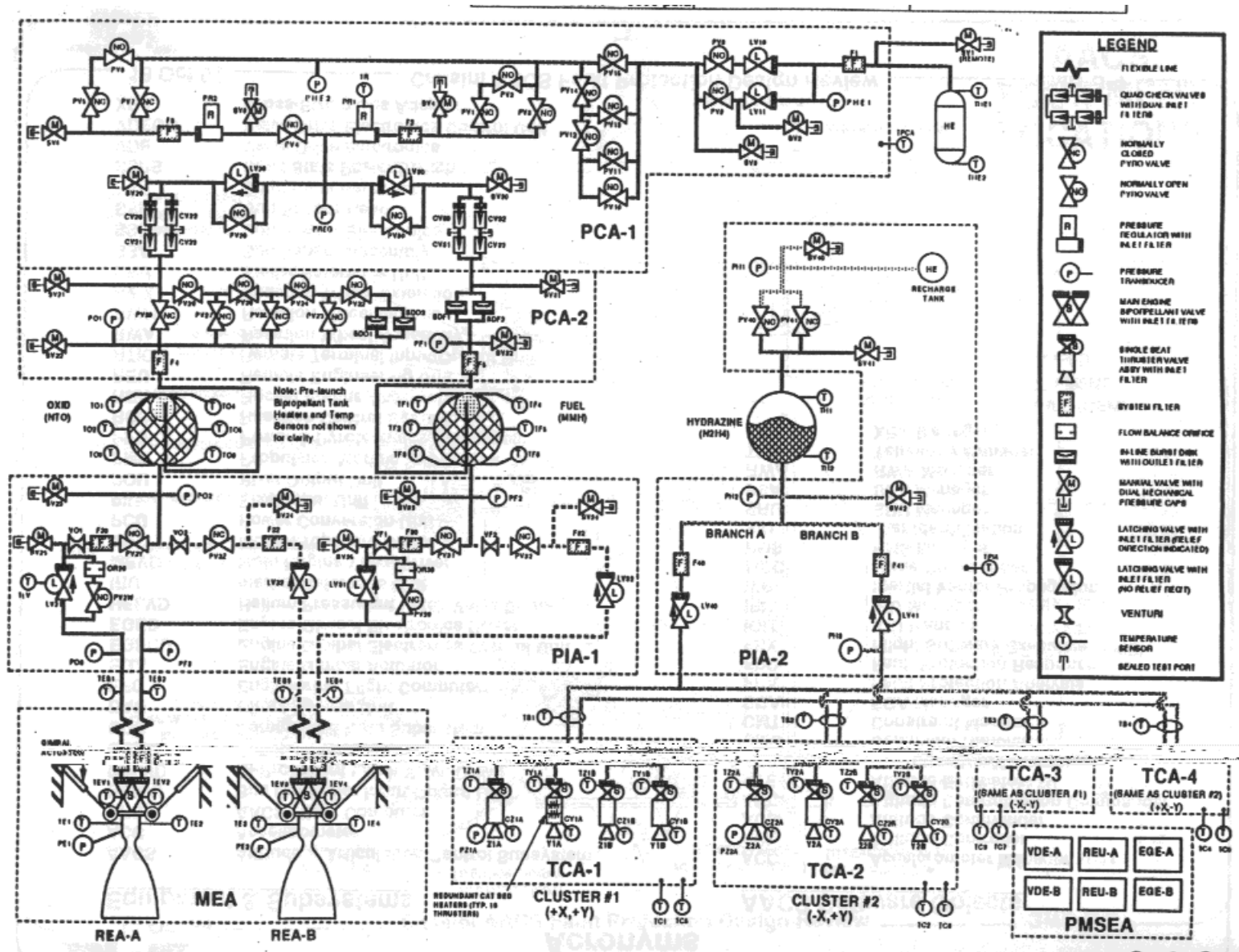
- ~ 1 billion \$
- 7 years to build
- 7 year cruise
- ~ 150 - 300 ground operators



- *150 million \$*
- *2 year build*
- *0 ground ops*



WJW
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Properties of Complex Autonomous Systems

Mobile Robots

Structure:

- 3D vision, articulated arms/legs
- mobile
- few
- mostly alike

Function:

- Navigation & path planning
- Map and terrain learning

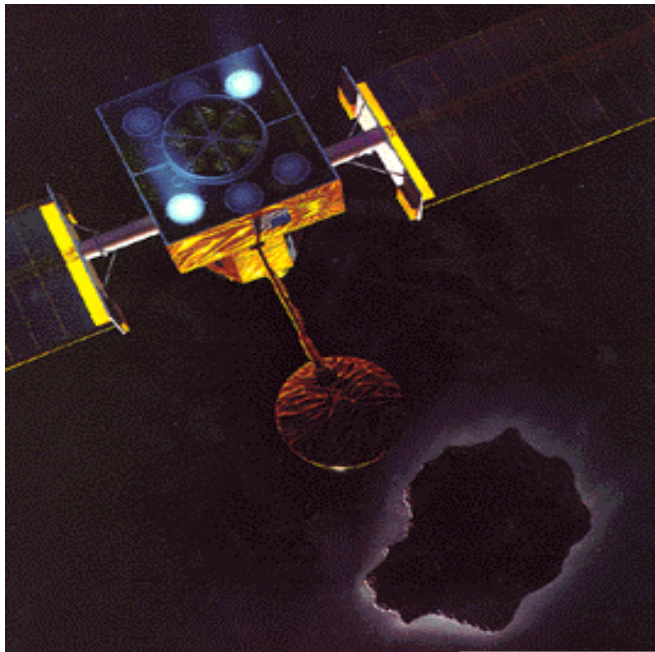
Immobile Robots

- 1D and binary sensors & actuators
- highly reconfigurable
- thousands
- heterogenous

- Control of internal systems
 - concious and autonomic control
 - immune, regulatory & nervous

The New Millennium

“With autonomy we declare that no sphere is off limits. We will send our spacecraft to search beyond the horizon, accepting that we cannot directly control them, and relying on them to tell the tale.”



*- Bob Rasmussen
New Millennium
Autonomy Team*

DS1 Launch 1998

NASA's Autonomous Systems

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture



Williams/Nayak

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SP2-11

AAAI-97 Tutorial SP2

Additional Examples of Complex Autonomous Systems

- Berkeley Path Project and BatMobile
- Xerox PARC and CMU Smart Building projects
- Honeywell onboard control of Boeing Jet liner
- Rockwell Automation Assembly-line control
- DARPA Survivable Systems Initiative
- European smart car initiative
- NASA New Millennium and Outer Planets programs
- NASA Human Exploration and Development of Mars
- NASA Reusable Launch Vehicle program